CLAIMS

Having thus described the aforementioned invention, I claim:

1. A device for on-line correction of patient motion in three-dimensional positron emission tomography wherein a positron emission tomograph device is used to collect coincidence event and position data, said device comprising:

a first digital pipeline latch for receiving said data collected by said positron emission tomograph device;

a plurality of multipliers disposed in parallel, each of said plurality of multipliers for receiving and multiplying a portion of said data to generate a product simultaneous with each other of said plurality of multipliers;

a second digital pipeline latch for simultaneously receiving said product from each of said plurality of multipliers;

a plurality of adders disposed in parallel, each of said plurality of adders for receiving and summing a plurality of said product from said plurality of multipliers; and

a third digital pipeline latch for receiving data from said plurality of adders, said data being representative of a pair of transformed coordinate points from a primary coordinate system to a secondary coordinate system;

whereby as said data is input to said first digital pipeline latch, said product of said data from an immediately previous said event is input to said second digital pipeline latch and completely transformed

data from a second immediately previous said data is input to said third digital pipeline latch, and whereby said event data is transformed from said primary coordinate system to said secondary coordinate system in real time.

2. The device of Claim 1 wherein said plurality of multipliers and said plurality of adders are provided to produce transformed coordinates from said primary coordinate system to said secondary coordinate system for each of a pair of detectors using the equations:

$$x_a' = d_{xx}*x_a + d_{xy}*y_a + d_{xz}*z_a + X ; \quad (1)$$

$$y_a' = d_{yx}*x_a + d_{yy}*y_a + d_{yz}*z_a + Y ; \quad (2)$$

$$z_a' = d_{zx}*x_a + d_{zy}*y_a + d_{zz}*z_a + Z ; \quad (3)$$

$$x_b' = d_{xx}*x_b + d_{xy}*y_b + d_{xz}*z_b + X ; \quad (4)$$

$$y_b' = d_{yx}*x_b + d_{yy}*y_b + d_{yz}*z_b + Y ; \text{ and} \quad (5)$$

$$z_b' = d_{zx}*x_b + d_{zy}*y_b + d_{zz}*z_b + Z ; \quad (6)$$

where:

X, Y, and Z are translational offsets from a point (x, y, z) in said primary coordinate system to a point (x', y', z') in said secondary coordinate system;

d_{xx}, d_{xy}, and d_{xz} are direction cosines between the x-, y-, and z-axes and the x' axis, respectively;

d_{yx}, d_{yy}, and d_{yz} are direction cosines between the x-, y-, and z-axes and the y' axis, respectively;

d_{zx}, d_{zy}, and d_{zz} are direction cosines between the x-, y-, and z-axes and the z' axis, respectively; and

a and b are two detectors in a detector pair.

3. The device of Claim 2 wherein said plurality of multipliers includes eighteen said multipliers, one each being provided to multiply one ordinate of one of said detector pair in said primary coordinate system with one said direction cosine as set forth in equations (1) through (6), and wherein said plurality of adders includes six said adders, one each being provided to sum three said products from said plurality of multipliers and one said translational offset as set forth in equations (1) through (6), whereby said transformed coordinates (x', y', z') for each of said pair of detectors are acquired.

4. A method for on-line correction of patient motion in three-dimensional positron emission tomography wherein a positron emission tomograph device is used to collect coincidence event data, said method comprising the steps of:

a) collecting data relative to a scan;

b) delivering said scan data to a processor having a first digital pipeline latch, a plurality of multipliers, a second digital pipeline latch, a plurality of adders, and a third digital pipeline latch;

c) multiplying selected groups of said data in said plurality of multipliers to simultaneously acquire a plurality products;

d) delivering said plurality of products to said second digital pipeline latch;

e) summing a selected group of said plurality of products

in said plurality of adders to acquire a plurality of sums representative of transformed coordinates from a primary coordinate system to a secondary coordinate system;

f) delivering said plurality of sums to said third digital pipeline latch.

The method of Claim 4 in said steps of c) multiplying selected groups of said data in said plurality of multipliers; and e) summing a selected group of said plurality of products in said plurality of adders, wherein said plurality of multipliers and said plurality of adders are provided to produce transformed coordinates from said primary coordinate system to said secondary coordinate system for each of a pair of detectors using the equations:

$$x_a' = d_{xx}*x_a + d_{xy}*y_a + d_{xz}*z_a + X ; \quad (1)$$

$$y_a' = d_{yx}*x_a + d_{yy}*y_a + d_{yz}*z_a + Y ; \quad (2)$$

$$z_a' = d_{zx}*x_a + d_{zy}*y_a + d_{zz}*z_a + Z ; \quad (3)$$

$$x_b' = d_{xx}*x_b + d_{xy}*y_b + d_{xz}*z_b + X ; \quad (4)$$

$$y_b' = d_{yx}*x_b + d_{yy}*y_b + d_{yz}*z_b + Y ; \text{ and} \quad (5)$$

$$z_b' = d_{zx}*x_b + d_{zy}*y_b + d_{zz}*z_b + Z ; \quad (6)$$

where:

X, Y, and Z are translational offsets from a point (x, y, z) in said primary coordinate system to a point (x', y', z') in said secondary coordinate system;

d_{xx}, d_{xy}, and d_{xz} are direction cosines between the x-, y-, and z-axes and the x' axis, respectively;

d_{yx}, d_{yy}, and d_{yz} are direction cosines between the x-, y-, and z-

axes and the y' axis, respectively;

d_{zx}, d_{zy}, and d_{zz} are direction cosines between the x-, y-, and z-axes and the z' axis, respectively; and

a and b are two detectors in a detector pair.

6. The method of Claim 5 wherein said plurality of multipliers includes eighteen said multipliers, one each being provided to multiply one ordinate of one of said detector pair in said primary coordinate system with one said direction cosine as set forth in equations (1) through (6), and wherein said plurality of adders includes six said adders, one each being provided to sum three said products from said plurality of multipliers and one said translational offset as set forth in equations (1) through (6), whereby said transformed coordinates (x', y', z') for each of said pair of detectors are acquired.

7. The method of Claim 4, before said step of c) multiplying selected groups of said data in said plurality of multipliers, further comprising the step of normalizing said data.

8. The method of Claim 7 wherein said step of normalizing said data comprises the steps of:

a) inputting event data into a first normalizing pipeline latch to provide a transaxial geometric correction value for said event;

b) providing a geometric correction value for said event;

c) inputting said geometric correction value and information regarding said event to a second normalizing pipeline

latch;

d) providing a dead time correction value for said event; and

e) performing an integer multiply of said geometric correction value and said dead time correction value.

9. The method of Claim 7, before said step of c) multiplying selected groups of said data in said plurality of multipliers, and after said step of normalizing said data, further comprising the step of histogramming said data.

10. The method of Claim 9 wherein said step of histogramming said data includes the steps of:

a) reading from a memory a current bin value indexed by a bin address;

b) applying said bin value produced by said memory together with a normalization value for said current bin to an adder; and

c) writing an output of said adder to said current bin.